Engineering surfaces for self cleaning and reducing drag

Understanding impact dynamics of bouncing and non-bouncing droplets on hydrophobic and superhydrophobic surfaces is useful in several technical applications. These surfaces exhibit low wettability and this property may be leveraged in the applications such as pesticide spray coating, drag reduction, anti-snow adhesion surfaces, self cleaning surfaces, and surface cooling via spray evaporative cooling and on spatially varying wettability surfaces. The effect of pitch of the pillars and impact velocity are studied for the impact dynamics of a microliter water droplet on a micropillared hydrophobic surface. Three distinct regimes, namely, non-bouncing, complete bouncing and partial bouncing are presented in Fig. 1. A critical pitch as well as impact velocity exists for the transition from one regime to another. This is explained with a demonstration of Cassie to Wenzel wetting transition in which the liquid penetrates in the grooves between the pillars at larger pitch or impact velocity.

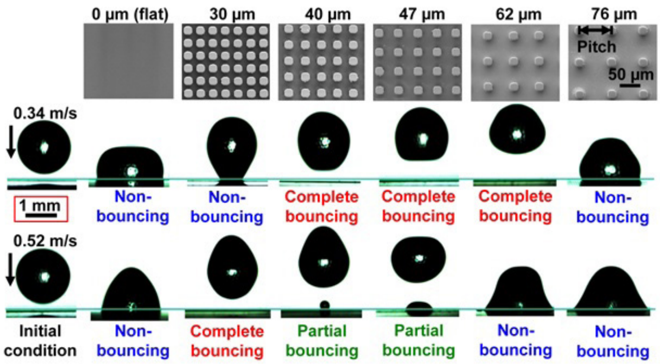

Fig. 1

In this work, a numerical methodology for modeling contact line motion in a Dual-Grid Level-Set Method (DGLSM) – solved on a uniform grid which is twice for interface that for the flow equations – is presented. A quasi-dynamic contact angle model, based on an experimental inputs, is implemented to model the dynamic wetting of a droplet, impacting on a hydrophobic or a super-hydrophobic surface. High speed visualisation experiments are also presented for the impact of a water droplet on hydrophobic surfaces, with non-bouncing at smaller and bouncing at larger impact velocity. The experimental results (Fig. 2) for temporal variation of the droplet shapes, wetted-diameter and maximum height of the droplet matches very well with the DGLSM based numerical results.

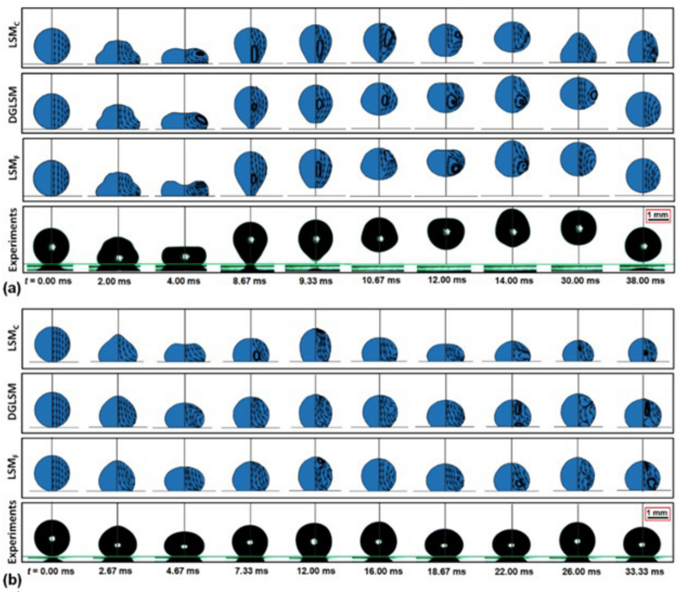

Fig. 2

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